Upper San Joaquin River Basin Storage Investigation

Fine Gold Reservoir

Surface Storage Option Technical Appendix to the Phase 1 Investigation Report

A Joint Study by:

Bureau of Reclamation
Mid-Pacific Region

California Department of Water Resources

In Coordination with:

The California Bay-Delta Authority

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Prepared by:

MWH

October 2003

SURFACE WATER STORAGE OPTION
TECHNICAL MEMORANDUM

FINE GOLD RESERVOIR

UPPER SAN JOAQUIN RIVER BASIN STORAGE INVESTIGATION

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Acronyms and Abbreviations

BRM	bedrock mortar
CEQA	California Environmental Quality Act
CFRF	concrete-face rockfill
cfs	cubic feet per second
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
Corps	United States Army Corps of Engineers
DWR	Department of Water Resources
elevation	number of feet above mean sea level
HEP	Habitat Evaluation Procedure
HMR	hydrometeorological report
Investigation	Upper San Joaquin River Basin Storage Investigation
MW	megawatt
NEPA	National Environmental Policy Act
PMF	probable maximum flood
PMP	probable maximum precipitation
RCC	roller-compacted concrete
Reclamation	Bureau of Reclamation
ROD	Record of Decision
TAF	thousand acre-feet
TCP	Traditional Cultural Place
TM	Technical Memorandum
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

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EXECUTIVE SUMMARY

The Upper San Joaquin River Basin Storage Investigation (Investigation) considered several potential storage options in the eastern San Joaquin Valley. This Technical Memorandum describes a potential dam and reservoir on Fine Gold Creek, a tributary to the San Joaquin River that enters Millerton Lake from the north.

The primary water source for Fine Gold Reservoir would be San Joaquin River water pumped from Millerton Lake. The new reservoir would function as a pump-back storage facility, with water pumped up from Millerton Lake for later release, allowing partial recovery of hydroelectric energy. Natural runoff from Fine Gold Creek would supplement the Millerton supply. Stored water released to Millerton Lake ultimately would be released to the San Joaquin River or diverted to the Friant-Kern or Madera canals. Pumping water from Millerton Lake to Fine Gold Reservoir would provide an opportunity to increase available flood storage space in Millerton Lake, which could then capture a larger portion of flood flows.

Two potential dam types could be constructed: a roller-compacted concrete structure or a concrete-face rockfill gravity dam. Two dam heights are considered, 380 feet and 580 feet, which correspond to total storage capacities of approximately 130 thousand acre-feet (TAF) and 780 TAF, respectively. The higher dam option would require construction of a saddle dam on the right (west) rim of the reservoir. During construction, a temporary cofferdam approximately 80 feet high would be required above the permanent dam site to divert Fine Gold Creek flows; a second cofferdam approximately 60 feet high would be required to keep water from Millerton Lake out of the construction zone. One or more diversion tunnels would be required. The number and placement of tunnels would depend on the dam type selected.

Geologic conditions appear suitable for dam construction. Raw materials could be obtained from within the potential reservoir inundation area.

Field costs for constructing each option were estimated at 2003 price levels. Field costs represent the direct costs to modify the dam and appurtenant features, and contain provisions for uncertainties. Additional study will be needed to determine costs for reservoir clearing; environmental mitigation; road relocation; acquisition of lands, easements, and rights-of-way; investigations and designs; or construction management, administration, and interest during construction. Table ES-1 summarizes costs for the storage options considered.

Estimates were developed of the amount of energy that would be required for pumping and that could be generated for a reservoir with a water storage capacity of 800 TAF. The range of energy potentially required and generated is shown in Table ES-2. The pumping-generation station, which would be located at Millerton Lake, was assumed to have an installed generating capacity of approximately 100 megawatts (MW) to 125 MW, provided by three or four units. This would allow operation at low as well as high rates of discharge.

**TABLE ES-1.
FINE GOLD RESERVOIR ESTIMATED CONSTRUCTION COST**

Dam Crest Elevation (feet above mean sea level)	Dam Height (feet)	Gross Storage (TAF)	Dam Type	Field Cost ($ Millions)
900	380	133	CFRF	160
			RCC	160
1,100	580	781	CFRF	400
			RCC	430

Key:
CFRF – concrete-face rockfill
RCC – roller-compacted concrete
TAF – thousand acre-feet

TABLE ES-2. ESTIMATED PUMPING REQUIREMENT AND GENERATING POTENTIAL FOR FINE GOLD RESERVOIR

Storage (TAF)	Avg. Annual Energy Generation (GWh)	Avg. Annual Pumping Energy Use (GWh)
800	70 - 100	130 - 170

Key:
GWh – gigawatt-hours
TAF – thousand acre-feet

Creation of Fine Gold Reservoir would be expected to cause adverse environmental impacts. Extensive pine and oak woodland habitat would be affected, as would pockets of riparian and wetland habitats. Vernal pools and special status species of plants, terrestrial wildlife, and fish may be present in the inundation area and in Fine Gold Creek. Pumped storage operations could affect water temperatures in Millerton Lake and cause fluctuations in water levels in both Millerton Lake and Fine Gold Reservoir. Lake level fluctuations would affect several species of fish.

No technical issues were identified that would physically prevent a dam from being constructed on Fine Gold Creek. However, further research would be required to more fully define the extent of resulting environmental impacts and how adverse environmental impacts could be mitigated. Fine Gold Reservoir was retained for further consideration in the Investigation as a surface water storage option.

CHAPTER 1. INTRODUCTION

The Bureau of Reclamation, in cooperation with the California Department of Water Resources (DWR), is completing the Upper San Joaquin River Basin Storage Investigation (Investigation), consistent with the CALFED Bay Delta Program Record of Decision (ROD), August 2000. The Investigation will consider opportunities to develop water supplies to contribute to water quality improvement and restoration of the San Joaquin River, and to enhance conjunctive management and exchanges to provide high-quality water to urban areas. The ROD indicated that the Investigation consider enlarging Friant Dam or developing an equivalent storage program to meet Investigation objectives.

The Investigation identified several potential surface storage sites to be initially considered through prefeasibility-level studies of engineering and environmental issues. This Technical Memorandum (TM), which was prepared as a technical appendix to the Phase I Investigation Report, presents findings from a prefeasibility-level review of a potential Fine Gold Dam and Reservoir.

STORAGE OPTION SUMMARY

Fine Gold Reservoir would be created by constructing a dam on Fine Gold Creek. The potential dam and reservoir would be located in Madera County, near the community of Friant, about 23 miles northeast of Fresno (Figure 1-1). The dam site is situated on the Fine Gold Creek arm of Millerton Lake, three-quarters of a mile upstream of the creek's former confluence with the San Joaquin River. Friant Dam lies about 5 miles downstream of the confluence. Fine Gold Creek and vicinity are shown in Figure 1-2.

Two dam sizes were considered, 380 and 580 feet high, which would impound a reservoir with storage capacities of 133 and 781 thousand acre-feet (TAF), respectively. Fine Gold Reservoir would be operated as a pump-back storage project. Water would be pumped from Millerton Lake up into Fine Gold Reservoir, for later release back to Millerton Lake and ultimate release to the San Joaquin River or diversion to the Madera and Friant-Kern canals. Local inflow from Fine Gold Creek would supplement water pumped from Millerton Lake. Hydroelectric energy could be generated during release from Fine Gold Reservoir to Millerton Lake.

SUMMARY OF PREVIOUS INVESTIGATIONS

In February 1991, WAVE Engineers, Inc., prepared an Initial Operation Study for the Fine Gold Water Conservation Project on behalf of Madera Irrigation District. The study evaluated the Fine Gold site for a potential dam and reservoir.

In January 2002, DWR prepared a Draft Reconnaissance Study of Fine Gold Creek Reservoir that revisited the previous study.

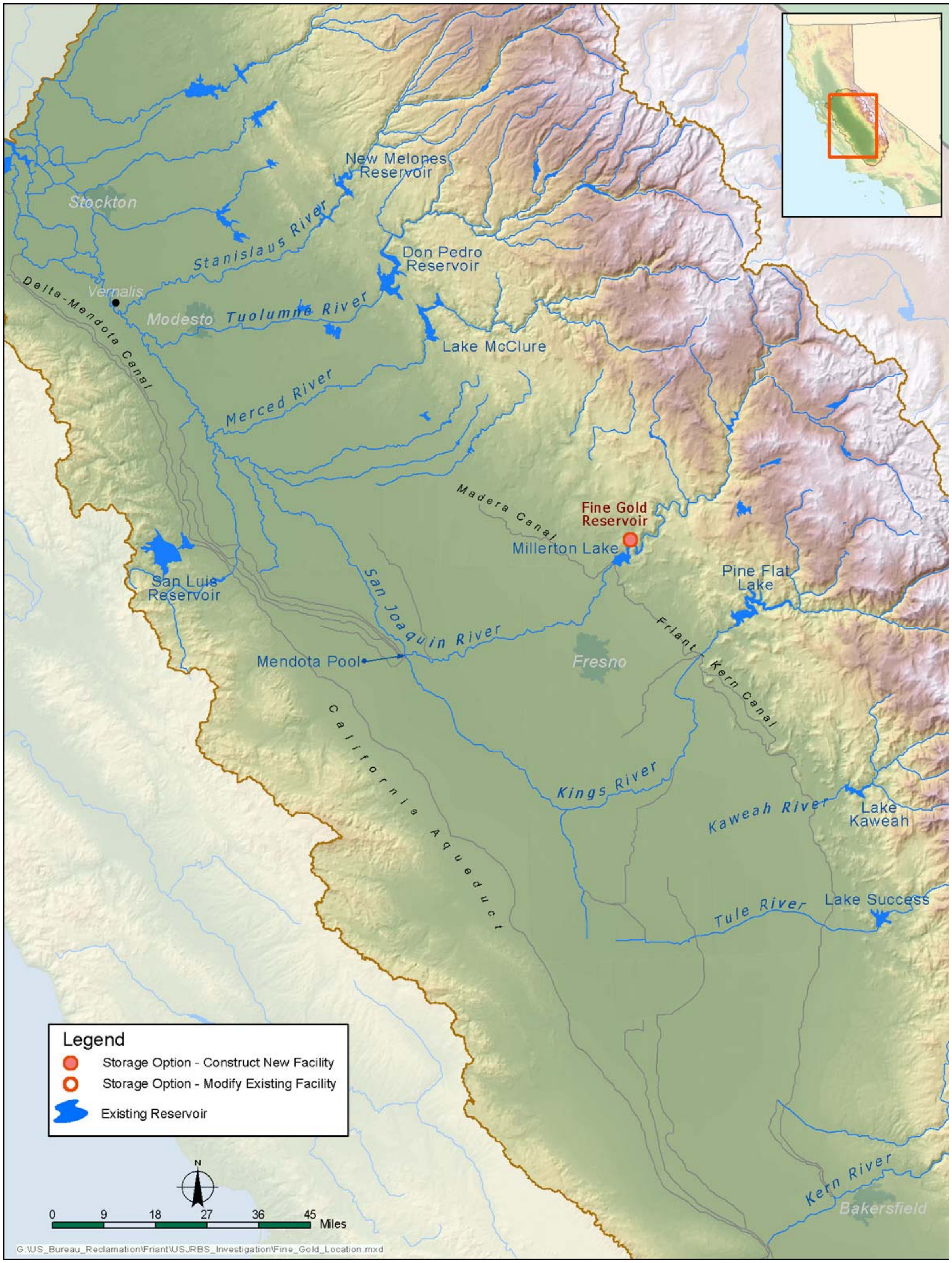

FIGURE 1-1. FINE GOLD RESERVOIR SITE LOCATION MAP

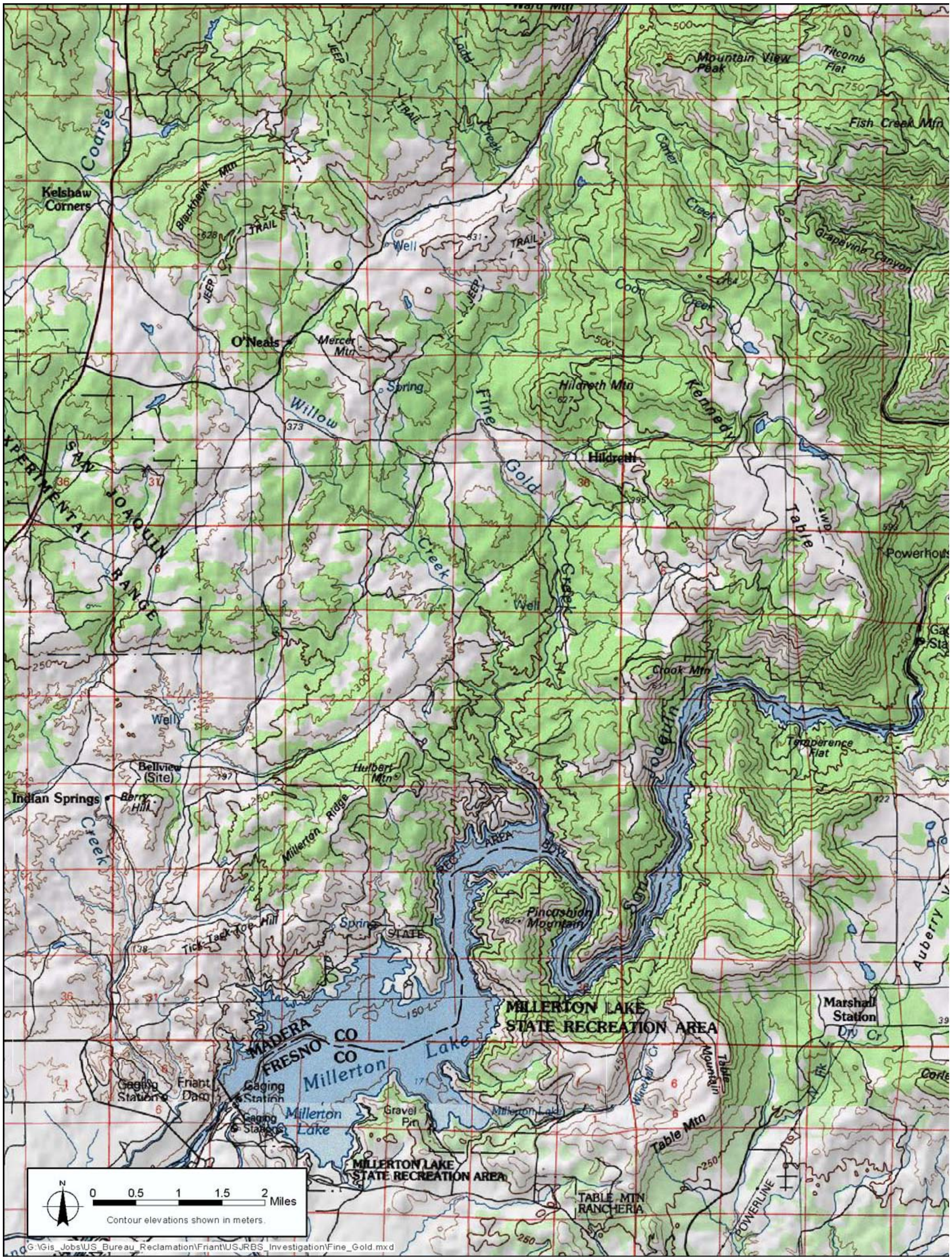

FIGURE 1-2. FINE GOLD CREEK VICINITY MAP

POTENTIAL IMPROVEMENTS

Two potential dam crest elevations were considered for this study, the lower one at 900 feet above mean sea level (elevation 900), and the other at elevation 1,100. The streambed at the potential dam site is at elevation 520, resulting in dam heights of 380 feet and 580 feet, respectively. Figure 1-3 shows the potential location of the dam and the area that would be inundated by the larger dam option.

Dam types well-suited to this site include roller-compacted concrete (RCC) and concrete-face rockfill (CFRF) gravity dams. A concrete thin arch dam type was not evaluated in this study, but could be considered in future studies for cost comparisons.

In addition to the main dam, low-level outlet works are planned for water deliveries and reservoir evacuation capability. Since this site is off-stream from the San Joaquin River, a pumping plant would be required to fill the reservoir. Associated with the outlet works and pumping plant is a power plant to enable power generation with releases into Millerton Lake. An uncontrolled spillway would pass flood flows. Details of the potential dam types and appurtenant structures are presented in Chapter 3.

Since the dam site is located within the influence of Millerton Lake, a downstream cofferdam would be necessary to allow normal operation of Millerton Lake during construction. An upstream cofferdam higher than the downstream cofferdam would also be required to provide sufficient head to pass diversion flows. To divert the 4 percent chance flood event (25-year return period) during construction, the peak discharge for the cofferdams would need to be approximately 80 feet high upstream of the dam site (depending on dam type) and 60 feet high downstream. Development of the frequency curve data used to determine requirements for flood routing during construction is discussed further in Chapter 3.

APPROACH AND METHODOLOGY

Information developed for preparation of this TM was based on a brief review of the prior studies listed above and field reconnaissance visits of the dam and reservoir site (see Appendices A and B).

Engineering and Geology

During a site visit on 12-14 June 2002, Reclamation engineers and geologists visually examined the proposed abutment locations, possible borrow areas and site access conditions (Reclamation, 2002c). Surface geologic mapping and evaluations for possible construction materials were also performed by Reclamation in July 2002 (2002c).

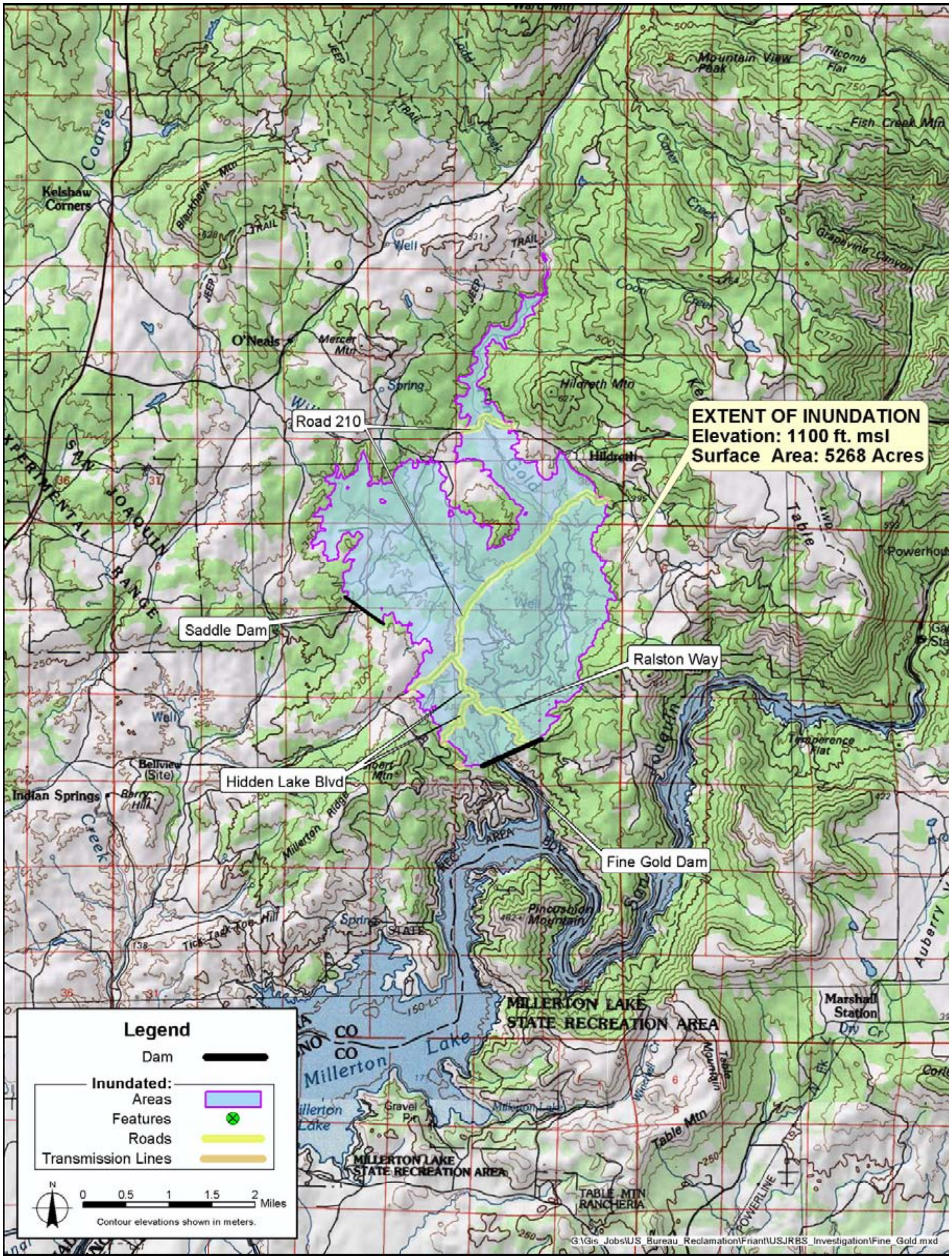

FIGURE 1-3. POTENTIAL STRUCTURES AND POTENTIALLY INUNDATED FACILITIES

The seismotectonic evaluation conducted by Reclamation for this study (2002b) was based on readily available information and is considered appropriate for prefeasibility-level designs only. Detailed, site-specific seismotectonic investigations were not conducted, nor were aerial photographs or other remotely sensed imagery evaluated for the seismotectonic analysis. More detailed, site-specific studies would be required for higher-level designs.

For prefeasibility-level planning studies, designs and analyses are typically quite general. Design layouts, sections, and dimensions for this study have been assumed based on standard practice and experience with similar facilities. Extensive efforts to optimize the design were not made, and only limited value engineering techniques were used at this level of study. Assumptions used for developing the designs are presented in subsequent chapters.

Cost Estimation

Estimates of field construction costs are based on prefeasibility-level designs and contain provisions for uncertainties. Estimates were prepared for different dam types and reservoir sizes. Field costs for construction were estimated at 2003 price levels and include direct costs to construct dams and appurtenant features. Cost estimates are presented in Chapter 3 with detailed worksheets in Appendix C.

Costs of road and bridge construction, relocation or acquisition of existing facilities, reservoir clearing, lands, easements, rights-of-way, environmental mitigation, investigations, designs, construction management, administration, and interest during construction are not included in the estimated field costs.

Hydropower Analysis

Hydropower specialists conducted a field reconnaissance trip in June 2003, viewing the potential dam site (Appendix A.2). Preliminary estimates of potential energy generation and use were produced using a spreadsheet approach based on output from the CALSIM hydrologic water balance model. In the spreadsheet analysis, assumptions were made regarding turbine, generator, and pump efficiencies, restrictions on minimum and maximum heads and flows, and head losses in conduits and equipment. From these data and assumptions, preliminary estimates were made of energy generated and used on an annual basis. Results reflect assumptions made at this level of study, and therefore give a preliminary indication of possible energy generation and use only.

Environmental Review

An environmental field reconnaissance trip was conducted on 29 May 2002 (Appendix B). During the field visit, specialists in botany, wildlife, aquatic biology, recreational resources, and cultural resources visually assessed existing environmental resources. Less accessible portions of the area that would be affected were viewed by airplane. Additional research was conducted using prior studies and available literature, the California Natural Diversity Database (CNDDB), topographic maps, and aerial photographs.

This information was used to preliminarily identify the extent to which potential environmental impacts might constrain the storage options under consideration. Where evident, opportunities for improving environmental resources or mitigating adverse effects were also noted. Surveys and consultations with external resource management or environmental agencies were not conducted.

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CHAPTER 2. PHYSICAL SETTING

This chapter describes elements of the potential dam and reservoir setting, including topography, geology and seismicity, hydrology, existing facilities, and the environment.

TOPOGRAPHIC SETTING

Regional topography consists of the nearly level floor of the San Joaquin Valley rising abruptly to moderately steep, northwest-trending foothills with rounded canyons. Farther east, the terrain steepens and the canyons become more incised. The canyons have been cut by southwest- to west-flowing rivers and associated large tributaries. The San Joaquin River is the main river in the area. The topography of the San Joaquin River basin rises to over elevation 12,000 in the upper watershed, located in the Sierra Nevada.

The potential dam site is located in the valley of the Fine Gold Creek arm of Millerton Lake. Fine Gold Creek flows generally southward. Elevations in the immediate area range from approximately elevation 520 at the potential dam site to just over elevation 2,000 in the adjacent ridges. The ground surface at the right abutment rises steeply, at a 2:1 horizontal to vertical ratio, to about elevation 900, then the slope flattens somewhat up to elevation 1,160, where it continues through a series of saddles to elevation 1,847 at Hulbert Mountain. The left abutment rises at an inclination of about 2:1 to about elevation 650, then flattens somewhat up to about elevation 1,100, before ascending through a series of saddles and hilltops to Crook Mountain at elevation 2,006. Throughout this TM, right and left are relative to a perspective looking downstream.

Available Topographic Mapping

Aerial photographs and data for topographic mapping were acquired on 8 August 2001, using LIDAR technology. The base maps were created using a model that produced topography with 10-foot contour intervals.

Available Aerial Photography

Oblique aerial photos of the sites were taken during flights made on 26 November 2001. The aerial photos of the sites are available from Reclamation. Aerial imagery of various types and scales can also be obtained from the archive files of the United States Geological Survey (USGS). Additional aerial imagery may also be available from the United States Department of Agriculture, Reclamation, and the United States Army Corps of Engineers (Corps).

GEOLOGIC AND SEISMIC SETTING

The site is located along the western border of the central portion of the Sierra Nevada Geomorphic Province at its boundary with the eastern edge of the Great Valley Geomorphic Province of California. Friant Dam, located downstream of the Fine Gold site, is founded on metamorphic rocks consisting of quartz biotite schist, intruded by aplite and pegmatite dikes and by inclusions of dioritic rocks. The contact of these metamorphic rocks with the Sierra Nevada batholith lies just east of Friant Dam in Millerton Lake.

The Sierra Nevada batholith is comprised of primarily intrusive rocks, including granite and granodiorite, with some metamorphosed granite including granite gneiss. The intrusive Sierra Nevada batholith rocks underlie most of Millerton Lake and the Fine Gold Dam site. Occasional remnants of lava flows and layered tuff are present in the Millerton Lake area at the highest elevations.

The central Sierra Nevada has a complex history of uplift and erosion. The predominant uplift tilted the western flank of the Sierra Nevada to the west. At the western border, rocks of the Sierra Nevada are overtopped by alluvium and sedimentary rocks of the Great Valley Province. The metamorphic rocks in the Friant Dam area dip steeply downstream to the west, and strike northwesterly. Erosion has resulted in thin alluvial cover.

Both dam abutments and the stream channel section are underlain by granite, with a granite or pegmatite dike trending upslope on the left abutment. Where exposed at the surface, in the bottom of drainages along Millerton Lake reservoir rim and in the left abutment dike, the granite is typically hard to very hard. Hard, erosion-resistant granite outcrops are scattered on the abutment slopes above elevation 600. Some of these outcrops are detached blocks of rock that range up to 25 feet in maximum dimension. Away from these exposures, the upper 1 to 10 feet of the granite are weathered in place, producing an intensely weathered to decomposed soil-like profile of soft to very soft rock at the ground surface.

Downstream of the proposed dam axis, the steep, water-scoured shoreline of the Fine Gold Creek arm of Millerton Lake exposes discontinuous zones of gray to brown foliated metamorphic rock lenses within the more widespread granitic rock. The metamorphic rocks are typically intruded by light gray granitic dikes.

Alluvium of unknown thickness occurs below the existing reservoir water surface in the Fine Gold Creek channel. The alluvial material probably ranges from fine- to coarse-grained sands, with rocks ranging up to 25 feet in maximum dimension that detached from the abutment slopes.

Unstable rock wedges, rock toppling, or landslides were not observed. The granite appears to be of adequate strength and stability for embankment, concrete gravity, RCC, or concrete arch structures. The granite also appears to provide an adequate foundation for a plunge pool if an overflow section through the center of a concrete arch dam is considered.

Site Geotechnical Conditions

No known adverse geologic/geotechnical conditions exist at the site that would require special consideration for design and/or construction. The foundation bedrock is considered competent for any of the potential dam types and appurtenant structures.

Seismic Hazard Analysis

There are no known faults at the Fine Gold site. Ancient faults were encountered at Friant Dam during its construction, but they were inactive. Overall, potential seismic hazard potential at the site is low. Preliminary earthquake loading analysis for this prefeasibility-level evaluation considered two types of potential earthquake sources: fault sources and aerial/background sources (Reclamation, 2002b).

Twenty-two potential fault sources for the site were identified, including those faults associated with the San Andreas fault, seven western Great Valley faults, seven eastern Sierra Nevada faults, the White Wolf fault of the southern San Joaquin Valley, and six faults of the Sierra Nevada Foothills fault system. No major through-going faults or shear zones have been identified in this area of the Sierra Nevada and historic seismicity rates are low.

The aerial/background seismic source considered was the South Sierran Source Block, the region surrounding the site. This region possesses relatively uniform seismotectonic characteristics.

Probabilistic seismic hazard analysis shows that the peak horizontal accelerations to be expected at the site are 0.13g with a 2,500-year return period, 0.17g with a 5,000-year return period, and 0.23g with a 10,000-year return period.

HYDROLOGIC SETTING

The drainage area at the Fine Gold Dam site covers approximately 90 square miles. The terrain is mostly mountainous with steep slopes and moderate to heavy forest cover. Elevations range from about 600 at the dam site, to about 4,400 along the northern basin boundary.

Rainfall

The Probable Maximum Precipitation (PMP) rainfall for Fine Gold Dam site was derived using the data and procedures described in Hydrometeorological Report (HMR) 58 (Corrigan et al., 1998). Because of the relatively low elevations for the Fine Gold Dam site basin, nearly all less than 4,000, snow cover and snowmelt were not considered part of the PMP calculations.

The PMP design storm distribution was the standard Reclamation PMP design storm for which the peak increment of rainfall occurs at the 2/3 point of the storm (hour 48 for a 72-hour storm), and decreasing incremental values of precipitation are alternated about the peak increment. Because of the relatively small basin size, no subbasin divisions were considered.

Runoff and Flood Data

Constant loss rates were selected reflecting the assumption that no portion of the basin would be covered with snow during the formation of the PMP hydrograph. Excess precipitation, after subtraction of the constant loss, was converted to runoff by standard Reclamation unit hydrograph techniques for the single basin considered for this dam site. Erosion and recharge are not typically considered when developing a PMP hydrograph. Consequently, the prefeasibility-level PMP hydrograph for this dam site represents a maximum runoff condition for clear water runoff with no consideration given to sediment flows or to groundwater recharge.

Prefeasibility-level Probable Maximum Flood (PMF) hydrographs were developed for the Fine Gold Dam site. HMR 58 was used as the source for the general and local storm PMP information. Precipitation for both types of storm is assumed to fall on a snow-free basin based on the relatively low terrain within the basin. The prefeasibility-level general storm PMF hydrograph has a peak of 33.2 cubic feet per second (cfs) and a 5-day volume of 59.4 TAF. The prefeasibility-level local storm PMF hydrograph has a peak of 36,100 cfs and a 2-day volume of 17.1 TAF.

The results of the flood studies are suitable for prefeasibility-level designs and cost estimates, but should be reviewed and updated as necessary before final designs are developed.

EXISTING FACILITIES

There are no existing facilities or structures located at the dam site. Friant Dam on the San Joaquin River creates an arm of Millerton Lake that partially inundates lower Fine Gold Creek. Houses are located on both sides of the arm, downstream of the potential Fine Gold dam site. Road 210, and smaller spur and access roads, traverse the watershed.

ENVIRONMENTAL SETTING

This section describes existing environmental resources at the potential dam and reservoir site, describing the botany, terrestrial wildlife, aquatic biology, recreational resources, cultural resources, existing land uses, and mineral resources.

Botany

Soils and geologic conditions consist of granitic, metamorphic, and mixed granitic-metamorphic types. Foothill woodland and riparian habitats are found in the area.

Eight special status plant species have the potential to occur in the area around Fine Gold Creek. These include six species Federally or State-listed as endangered or threatened: San Joaquin Valley Orcutt grass (Federally listed as threatened and State-listed as endangered), succulent owl's-clover (Federally listed as threatened and State-listed as endangered), Bogg's Lake hedge-hyssop (State-listed as endangered), Hartweg's pseudobahia (Federally and State-listed as endangered), Mariposa pussypaws (Federally listed as threatened), and tree anemone (State-listed as threatened).

The first three are vernal pool species with low to moderate probability of occurring within the potential reservoir area. Of the remaining endangered or threatened species, the tree anemone could occur in the area; Hartweg's pseudobahia is a grassland species with low probability of occurrence; and Mariposa pussypaws has moderate to high probability of occurrence because suitable substrate is present. The other two special status species are Madera linanthus and orange lupine, both California Native Plant Society (CNPS) List 1B species with potential to occur in the area.

Wildlife

Fine Gold Creek is surrounded by foothill pine–oak woodland habitat with pockets of grassland, wetland, and riparian habitat associated with hillside seeps and vernal pools. Varying degrees of riparian habitat occur along the stream. Upland habitats have been seriously degraded due to cattle grazing.

A diverse wildlife community is expected. Several sensitive species of wildlife are known to have had a presence in the general area, including California tiger salamander, western spadefoot toad, and fairy shrimp from vernal pools. Western pond turtles occur in Fine Gold Creek, and foothill yellow-legged frogs and tri-colored blackbirds are also likely.

Aquatic Biology/Water Quality

The arm of Millerton Lake that presently inundates lower Fine Gold Creek channel is narrow and moderately steep-sided. Riparian vegetation is well-developed, especially in the upstream end of the arm. Immediately upstream of the reservoir, Fine Gold Creek runs through a steep gorge filled with very large boulders that shelter the stream. Water quality and aquatic biological resources of this portion of the reservoir are probably largely similar to those present for the Friant Dam and Temperance Flat Dam storage options, described in separate TMs.

Aquatic biological resources of Fine Gold Creek and its potentially inundated tributaries have not been determined. Because of the relatively low elevation, the fish are probably warm-water species such as green sunfish and California roach. California roach is a native species, and the San Joaquin Valley subspecies (or “form”) is on the “Watch List” of the State of California Fish Species of Special Concern. Further research would need to be conducted to determine if this species occurs.

Recreation

Fine Gold Creek traverses private property. No developed recreation facilities are within the immediate site area. It is likely, however, that some recreation occurs in the area, particularly where unpaved roads provide access to undeveloped areas along Fine Gold Creek. Recreation activities may include angling, hiking, nature viewing, picnicking, camping, mountain biking, and off-highway vehicle use. Some recreational mining, such as gold dredging or panning, may also occur. Boaters using Millerton Lake can access the lower portion of Fine Gold Creek.

Cultural Resources

The lower portion of Fine Gold Creek is within traditional territory of either the Northfork Mono people (Spier, 1978a) or the Dumna/Toltichi Yokuts (Kroeber, 1925), while the upper portion of the drainage is in Chuckchansi Foothill Yokuts territory (Spier, 1978b). Some Northfork Mono hamlets are known to have been located on lower Fine Gold Creek (Gifford, 1932; Spier, 1978a). Chuckchansi people presently live on and around the Picayune Rancheria in Coarsegold.

A recent archaeological records search by Reclamation archaeologists indicates the presence of three known archaeological sites within the potential reservoir pool (Welch, 2002). Two of the sites are prehistoric, with bedrock mortars (BRMs) and lithics; the third is a standing two-story house.

Land Use

The area appears to be largely undeveloped and in relatively pristine natural condition. Some rural residential uses, such as scattered single-family homes and related farm structures and access roads, are present in the area. Road 210, Hidden Lake Boulevard, and Ralston Way traverse the potential reservoir area below elevation 1,100.

Mineral Resources

The Hildreth District of the Fine Gold Creek drainage was one of three major mining districts around Millerton Lake (Rivers, 1995). In May 2002, a “glory hole” mining site was observed in a granite outcrop along Fine Gold Creek near Millerton Lake. An associated foot trail, with dry laid rock walls, is suggestive of a placer mining sluice.

CHAPTER 3. STORAGE STRUCTURES AND APPURTENANT FEATURES

This chapter describes the technical aspects of designing and constructing a potential dam, reservoir, and appurtenant features at the Fine Gold Creek site. It addresses considerations regarding constructibility, and presents estimated field costs for dam construction.

STORAGE STRUCTURES

The potential Fine Gold Creek site is suitable for concrete arch, RCC, and CFRF dam types. A central-core earthfill dam is not considered viable due to limited availability of plastic, fine-grained material required for the core. An asphaltic-core earthfill dam may be viable for this site, but was not considered due to limited use and experience with this type of dam within the United States.

Upstream and downstream cofferdams are required for diversion of stream flows during construction and to prevent inundation of the site from Millerton Lake. The cofferdams, sized for estimated diversion flows and dam type, are detailed in the section that discusses appurtenant conveyance features.

Concrete Arch Dam

Foundation conditions are excellent for a concrete arch dam. However, the abutments are uniform with relatively flat slopes, resulting in a wide canyon that would require potentially large volumes of concrete. Therefore, prefeasibility-level designs and cost estimates were not developed for a conventional concrete arch dam.

Concrete (RCC) Gravity Dam

A representative cross section for the RCC gravity dam options is shown on Figure 3-1. The design is based on standard practice as described in Design of Gravity Dams (Reclamation, 1976). The cross section consists of a vertical upstream face with a 0.75H:1V downstream face. The mass of the dam would be constructed with RCC. The upstream and downstream faces of the dam would be covered with conventional concrete-facing elements to provide a more durable surface on the exposed faces of the dam. Leveling concrete requirements were estimated for the dam foundation (an average thickness of 1 foot was assumed) and a conventional concrete cap was provided on the dam crest. The dam crest width and details would be similar to the existing Friant Dam.

Foundation grouting would consist of a single curtain with an assumed spacing of 10 feet. A drainage gallery would be placed in the RCC above the high tailwater elevation. Drainage holes on 10-foot centers would be drilled from the gallery into the foundation with additional drain holes being drilled from the dam crest into the gallery. For the low dam, the grout holes are assumed to be 150 feet into the foundation, and the drain holes would be 100 feet into the foundation. For the high dam, the grout holes are assumed to be 250 feet into the foundation, and the drain holes would be 200 feet into the foundation.

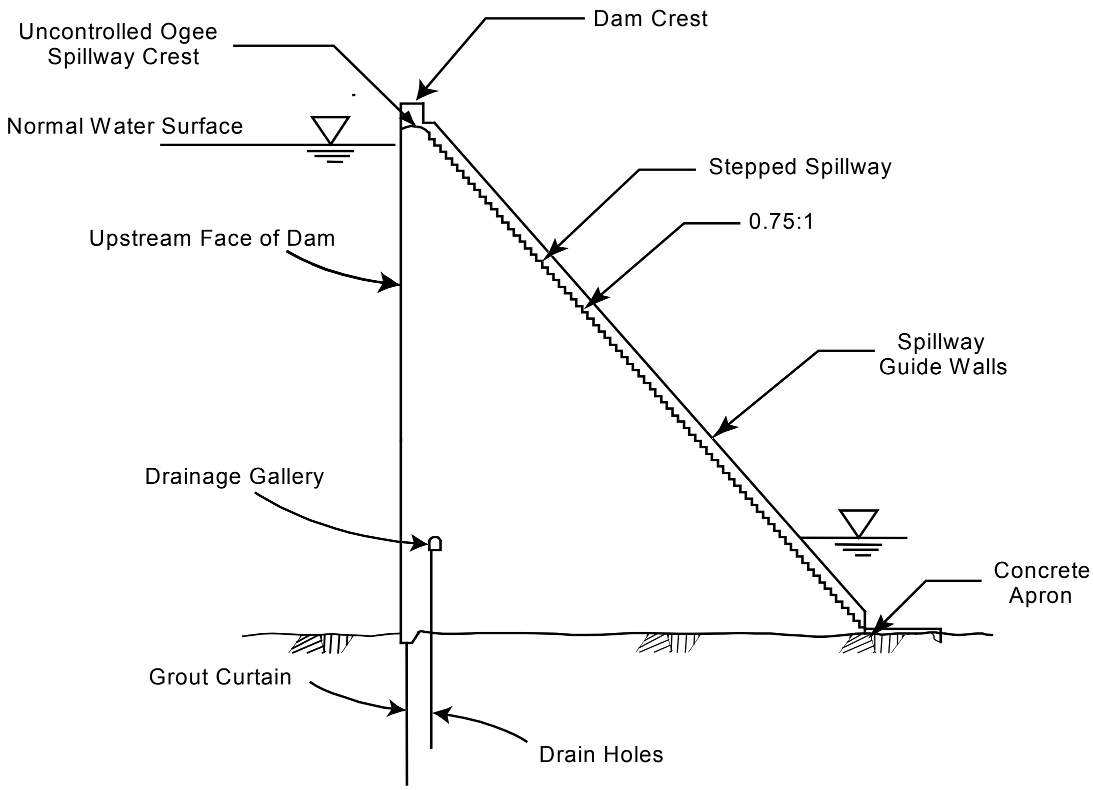

FIGURE 3-1. RCC GRAVITY DAM CROSS SECTION

The downstream slope of 0.75H:1V was used for developing the prefeasibility-level designs, but preliminary stability analyses showed that a steeper slope would likely work, especially for the low dam.

For the high dam option, with crest at elevation 1,100, a saddle dam would be required on the right reservoir rim. The saddle dam would be about 100 feet high and 3,200 feet long. The cross section would consist of a central core, upstream and downstream filter zones with an additional transition zone, riprap, and downstream slope protection.

Concrete-Face Rockfill Dam

The cross section for the CFRF option is shown in Figure 3-2. The design is based on standard practice, as described in Concrete-Face Rockfill Dam: II. Design (Cook and Sherard, 1987). The cross section includes a concrete deck, which provides the impervious barrier for the dam. Beneath the deck is a layer of silty/clayey sand and gravel (Zone 2), which provides the placement surface for the concrete deck and a secondary water barrier for seepage passing through joints in the deck. Below Zone 2 is the first of three rockfill zones:

Zone 3A provides a transition to the coarser zones downstream, and consists of gravel and cobble sizes. The two remaining zones are designated upstream (Zone 3B) and downstream (Zone 3C) for their relative position to the dam centerline. Zone 3B would have a greater amount of compaction to minimize settlements. Zone 3C could have less compaction due to its location within the cross section. Upstream of the concrete deck, material (Zone 1A) would be placed over the perimeter joint to prevent seepage and minimize joint damage from reservoir debris. The Zone 1A material would be primarily fine-grained and relatively impermeable. A stability zone would be placed over Zone 1A to provide a buttress for greater slope stability.

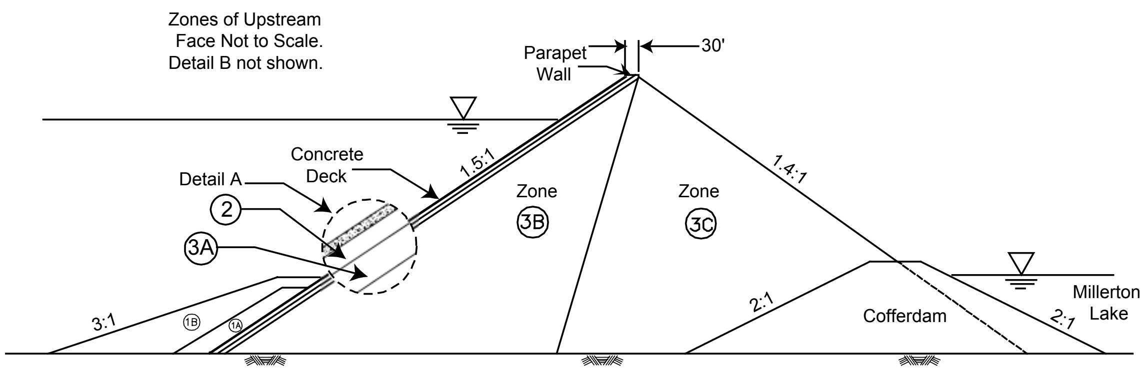

FIGURE 3-2. CFRF DAM CROSS SECTION

Foundation grouting would consist of a single row curtain with an average depth of 250 feet, and companion blanket grouting with rows on either side of the curtain. The blanket holes would have an average depth of 30 feet. Spacing of the curtain holes is 30 feet and the spacing of the blanket holes would be 10 feet. Closure pattern grouting is assumed to achieve a complete cutoff.

RESERVOIR AREA AND STORAGE

Reservoir area and capacity data are summarized in Table 3-1 for the two dam sizes considered. Curves showing storage volume and reservoir area vs. elevation are shown in Figure 3-3.

APPURTENANT FEATURES

This section discusses major appurtenant features associated with the potential dam and reservoir.

TABLE 3-1. RESERVOIR AREA AND CAPACITY

Crest Elevation (feet above mean sea level)	Area (acres)	Storage (acre-feet)
900	1,420	132,595
1,100	5,307	780,525

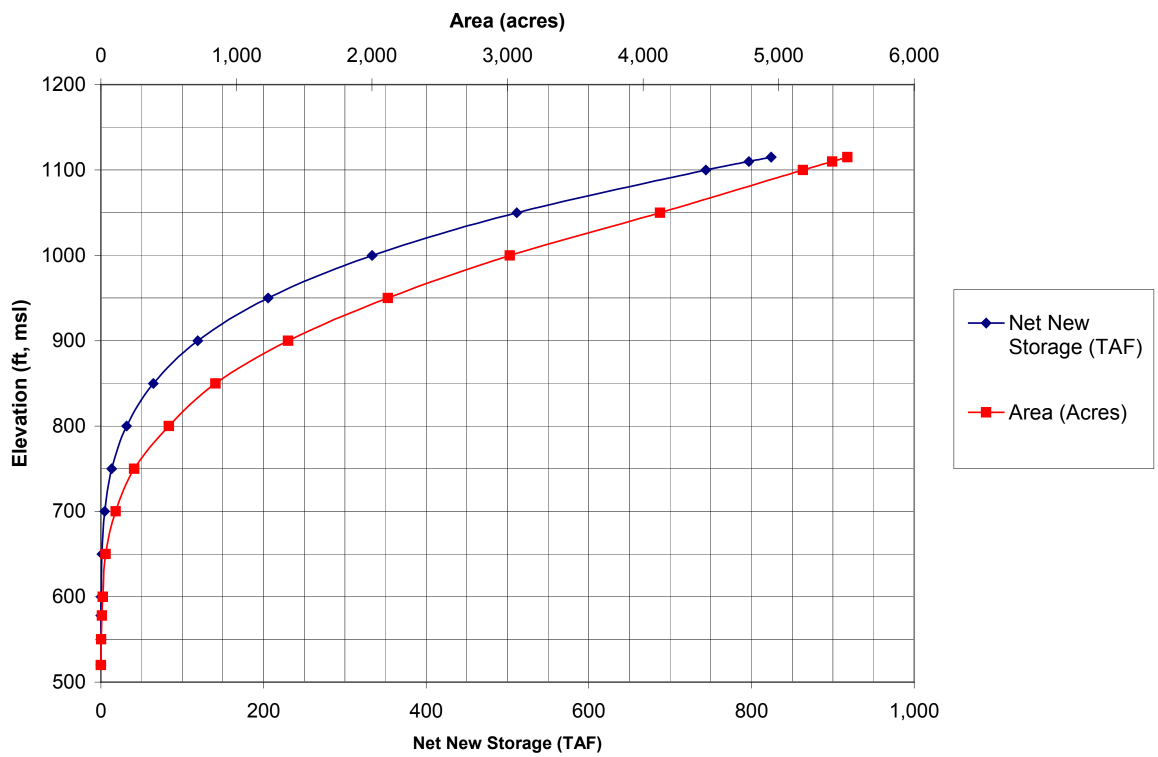

FIGURE 3-3. ELEVATION VS STORAGE AND AREA RELATIONSHIPS

Spillway

Design of the spillway for all options was based on passing a peak discharge of 30,000 cfs. This would be accomplished using an uncontrolled ogee crest spillway with a crest length of 150 feet, and a head of 15 feet. For the rockfill dam options, the spillway would be located on the left abutment. The downstream channel would be excavated through the existing rock abutment, and would daylight into a natural draw that leads back into the reservoir. A reinforced concrete training wall would be constructed within the first 100 feet of the channel to control flows within the vicinity of the dam. Energy dissipation would be controlled by the tailwater at the end of the natural channel, which would be in the range of 30 to 50 feet deep, depending on the level of Millerton Lake. For future designs, a labyrinth spillway could be considered for raising the crest elevation and providing more storage and reducing the overall width of the spillway, including the outlet channel.

For the concrete dam options, the spillway overflow section would be located near the center of the dam. Guide walls would be provided to contain flows within the width of the spillway crest. Energy dissipation would be accomplished as the flow passed over the stepped downstream face of the dam. A concrete cutoff would be provided at the toe of the dam to ensure undercutting did not occur. The depth of tailwater is expected to be 30 to 50 feet for this option.

Outlet Works

The outlet works layout for both dam types would consist of a trashracked intake structure, a water conveyance system, and a regulating gate with an upstream guard gate. The energy from releases would be dissipated in the tailwater from Millerton Lake (plunge pool). The size of each conveyance system would be dictated by diversion during construction (both high and low CFRF dams), reservoir evacuation (high RCC dam), or normal reservoir operation requirements (low RCC dam). Bulkheads would be required for each intake structure, and the CFRF dam options would require an outlet within the upstream end of the tunnel. The number and size of regulating gates and guard gates for the low and high dam options would be based on satisfying normal reservoir release requirements and reservoir evacuation requirements, respectively.

The spillway, in combination with outlet works discharges and reservoir surcharge capacity, would be capable of safely passing both the general storm PMF (peak inflow of 33,200 cfs, and 5-day volume of 59.4 TAF) and/or the local storm PMF (36,100 cfs peak inflow and 2-day volume of 17.1 TAF).

Conveyance

Prefeasibility-level designs for the appurtenant structures were based on the assumption that Millerton Lake would be continuously operated within the approximate elevation range of 550 to 575. Storage at the Fine Gold site could be fed by gravity into Millerton Lake. Downstream releases could use the existing conveyance system at Friant Dam.

Diversion during construction for all dam options was based on passing a peak discharge of 5,000 cfs, which corresponds to an approximate 25-year return period. Diversion for the rockfill dam options would be accomplished by constructing a 14-foot diameter tunnel through the left abutment. The tunnel would later serve as the outlet works for the dam. Diversion for the concrete dam options would be accomplished by installing two 10-foot-diameter steel conduits through the base of the diversion cofferdams and the main RCC dam. This installation would be removed following construction, except where it passed below the RCC dam, where it would be plugged.

An upstream cofferdam for the rockfill dam options would need to be placed to elevation 655 (approximately 80-foot height), and the upstream cofferdam for the RCC dam options would need to be placed to elevation 590 (approximately 25-foot height). Downstream cofferdams would need to be placed to elevation 578 (approximately 60-foot height) for all options, to accommodate normal reservoir operations for Millerton Lake.

Pumping Plants

The majority of water for filling Fine Gold reservoir would come from Millerton Lake. For designs and cost estimates, three pumps and one pump turbine were selected for the head range that might be encountered during normal operations. These units would be housed in a plant at the toe of the RCC dams, and at the downstream end of the diversion tunnels for the CFRF dams. The combination of reservoir head and capacity and current operating procedures at Friant Dam was used to select the number and size of pumps and to set a reasonable operating range for power generation. Power generation with lower reservoir levels does not appear to be economically feasible, so less expensive “pure pumps” would be provided for those ranges of reservoir level for which power generation benefits would be minimal. At the lower reservoir levels, releases would be made through the outlet works bypass valves. Table 3-2 shows the configuration of pumps and pump turbines for the two dam levels.

TABLE 3-2. PUMP HEAD RANGE

Facility	Low Dam Head Range (feet)	High Dam Head Range (feet)
No. 1 pump	25 to 55	50 to 90
No. 2 pump	55 to 100	90 to 160
No. 3 pump	100 to 180	160 to 290
No. 1 pump turbine	180 to 330	290 to 530

Saddle Dam

For the high dam option, with crest at elevation 1,100, a saddle dam would be required on the right reservoir rim. This saddle dam would be about 100 feet high and 3,200 feet long. The cross section consists of a central core, upstream and downstream filter zones with an additional transition zone, riprap, and downstream slope protection.

CONSTRUCTIBILITY

This section discusses issues of concern related to constructing the potential dam, reservoir, and appurtenant features.

Land, Rights-of-Way, and Easements

Land required for constructing the facilities is apparently in private ownership, and would have to be acquired. Additionally, the potential reservoir areas include both public and private land, which also would have to be acquired. Private land within the potential reservoir includes up to about 10 residences for the larger reservoir, and 2 residences for the smaller reservoir.

Significant portions of the reservoir areas can be accessed only by private roads or across private land.

Based on visual inspection of utility markers, there are no pipeline, communication, or power easements through the dam site. Types and locations of utilities serving Hidden Lake Estates above elevation 1,100 near the dam site were not identified. Typical utilities and easements serving residences are located in the reservoir area.

Access

Access to the right abutment through the uplands and the upper left abutment is restricted by private land and/or roads. Access to other areas at the dam site is generally over public roads or across public lands.

Borrow Sources and Materials

Rockfill can be quarried from the reservoir area and/or obtained from the excavation that would be required for constructing the dams and appurtenances.

Earthfill is available only in limited quantities near the potential dam site. Low plasticity, fine-grained soil occurs in the reservoir area.

Processed sands and gravels could be supplied by commercial sources and/or by crushing and processing rock quarried from the reservoir area or material excavated for the dam and appurtenant structures.

Concrete aggregates can be obtained from commercial sources and/or crushing and processing quarried rock in the reservoir area.

Foundations

Foundations for any of the options would be in sound granitic rock, as described in the geology section of this report. No special foundation considerations are known at this site at this time. Foundation preparation would be typical for each option. Excavation for the concrete gravity dams was assumed to be an average of 4 feet to remove overburden and weathered rock.

Staging and Lay-Down Areas

Areas for construction use, staging, and lay -own would likely be located upstream of the dam site within the reservoir area.

Power Source

High voltage grid power is available from the branch connecting with the Kerckhoff hydroelectric project. Lower voltage electrical service is available from existing trunks supplying local residences.

Contractor Availability and Resources

All options would be typical of heavy construction for the western United States. For the high dam options, several contractors might need to form a consortium to perform construction of this size.

Construction Schedule and Seasonal Constraints

The climate of central California is mild. Climate data for the last half of the 20^{th} century at Friant show no snow on average for any month. The coldest month is January with an average high and low of 55° and 36° Fahrenheit (F), respectively. The hottest month is July with an average maximum temperature of 100°F. The wet season is December through March with an average monthly rainfall of roughly 2.5 inches. The options considered in this TM are immune to these climate conditions and year-round construction is assumed. Appendix E contains tabulated climatic data.

Flood Routing During Construction

A frequency curve of peak flow values for the basin was developed as part of the flood studies to determine diversion flow requirements during construction. These data were developed using the USGS National Flood Frequency program. Results of this study are presented in Table 3-3.

TABLE 3-3. PEAK FLOOD FLOWS

Return Period (years)	Peak Flow (cfs)
2	960
5	2,160
10	3,110
25	5,160
50	6,710
100	8,910

Key:
cfs – cubic feet per second

A peak discharge of 5,000 cfs with a return period just under 25 years was used to size the diversion structures for each option.

Environmental Impacts During Construction

It is expected that environmental impacts during construction could be mitigated with proper planning and implementation of best management practices. Standard procedures would be used to minimize air quality (dust) and water quality concerns. Air quality issues could be mitigated by dust control measures for quarrying, material processing, and construction of the dam.

All construction equipment should have spark arresters, and fire control equipment should be kept readily accessible during construction. Construction water would have to be controlled and provisions made for runoff and erosion control. A spill control plan would be needed to control any construction-related fuels, lubricants, and other materials. A cultural survey would have to be conducted to identify any ancestral American Indian or historic artifacts, and construction activities would be restricted in those areas.

This site is in a primarily rural area with little habitation except at Hidden Lake Estates on the right abutment. Due to the size of the job, it would be preferable to use on-site materials for construction to minimize haul on public roads and thus reduce traffic concerns. For comparison of options, noise levels resulting from construction activities would be about the same. Most noise would be generated by the processing plant, which is typical for construction of this type. The work includes typical construction practices and procedures, which would not be expected to have environmental impacts beyond those of standard large construction projects.

Permits

Since the options include construction within the existing Millerton Lake, typical permits through the Corps would have to be obtained for working in waters of the United States. Standard water quality and air quality permits could also be required for this work (401, 402, 404). All options considered would require the same permits.

It is probable that both Federal and non-Federal sponsors would be involved in the implementation of any project, which would complicate the permitting process. Permits could be required from the permitting agencies listed in Table 3-4.

In addition, the following agencies could be involved in the review of permit conditions:

- Bureau of Indian Affairs
- BLM
- State Historic Preservation Office
- Advisory Council on Historic Preservation
- United States Fish and Wildlife Service (USFWS)

TABLE 3-4. POSSIBLE PERMITS REQUIRED

Permit	Permitting Agency
Permit to Construct	FERC, DSOD, Madera County
Encroachment	Caltrans, Madera County
Air Quality	CARB, Madera County
Low/No Threat NPDES	RWQCB
Waste Discharge	RWQCB
401 Certification	SWRCB
Blasting	Madera County
Stream Bed Alteration	CDFG
Fire/Burn	CDF, Madera County
Key:	
CARB	California Air Resources Board
CDF	California Department of Forestry
CDFG	California Department of Fish and Game
DSOD	Department of Safety of Dams
FERC	Federal Energy Regulatory Commission
NPDES	National Pollutant Discharge Elimination System
RWQCB	Regional Water Quality Control Board
SWRCB	State Water Resources Control Board

In obtaining these various permits, several plans would need to be prepared and submitted to the responsible agencies for review and approval, including:

- Construction Plan and Summary Documents
- Quality Control Inspection Plan
- Highway Notification Plan
- Blasting Plan
- Noise Monitoring Plan
- Water Quality Monitoring Plan
- Noxious Weed Control Plan
- Bat Protection Plan
- Management Plan for Avoidance and Protection of Historic and Cultural Properties
- Storm Water Pollution Prevention Plan
- Spill Prevention/Containment Plan
- Visual Quality Control Plan
- Dust Control and Air Quality Plan

Another important regulatory requirement involves compensation/mitigation for habitat loss. In October 1998, USFWS issued its draft Coordination Act Report and Habitat Evaluation Procedure (HEP Analysis). The HEP Analysis delineates how compensation for adversely affected baseline habitat and wildlife conditions is to be determined.

If power generation is included in a project or is modified for an existing project, the Federal Energy Regulatory Commission could become involved for permitting new facilities that would be operated by a non-Federal entity.

COSTS

Field costs for constructing each option were estimated at 2003 price levels. Table 3-5 summarizes these costs for the raise options considered.

Construction Costs

For each option, field costs represent estimated direct costs to modify the dam and appurtenant features, plus allowances for mobilization (5 percent), unlisted items (15 percent), and contingencies (25 percent). Additional study will be needed to determine costs for reservoir clearing, environmental mitigation, road relocation, land acquisition, easements, and rights-of-way. Costs of investigations, designs, construction management, administration, and interest during construction are considered indirect costs and are not included in field cost estimates. Details of the estimates are shown in Appendix C.

TABLE 3-5.
FINE GOLD RESERVOIR ESTIMATED CONSTRUCTION COST

Dam Crest Elevation (feet above mean sea level)	Dam Height (feet)	Gross Storage (TAF)	Dam Type	Field Cost ($ Millions)
900	380	133	CFRF	160
			RCC	160
1,100	580	781	CFRF	400
			RCC	430

Key:
CFRF – concrete-face rockfill
RCC – roller-compacted concrete
TAF – thousand acre-feet

Operation and Maintenance Cost

Operations and maintenance costs have not been estimated for options considered in this TM, consistent with the prefeasibility-level of analysis applied to other storage options in the Investigation. As the Investigation progresses, Reclamation will estimate operations, maintenance, and replacement costs by applying representative figures based on a review of other similar work and agency guidance.

SYSTEMS OPERATION

Systems operation studies of reservoir yield for potential alternative uses are presented in the Phase 1 Hydrologic Modeling TM.

CHAPTER 4. HYDROELECTRIC POWER OPTIONS

Fine Gold Reservoir would be a pump-back project. Water would be pumped from Millerton Lake to the new reservoir and later released to Millerton Lake for ultimate release to the San Joaquin River and/or delivery via the Madera and Friant-Kern canals. Pumping water from Millerton Lake to Fine Gold Reservoir would allow the additional capture of San Joaquin River water at Friant Dam. Electricity would need to be supplied to power the pump-turbines when pumping. This energy requirement would be partially offset by generation of electricity from the pump-turbine when water was released back to Millerton Lake.

This chapter explains the methodology used to estimate the potential electric energy generation and use by Fine Gold Reservoir, and presents estimated results.

HYDROPOWER ANALYSIS METHODOLOGY

Preliminary estimates of potential energy generation and potential energy required for pumping were made using a spreadsheet approach based on data from the CALSIM hydrologic water balance model. CALSIM simulates the operation of major water projects throughout California and is widely used to identify how potential projects and actions would affect system-wide water operations. During Phase 1 of the Investigation, CALSIM was revised to reflect the decision-making process used to allocate water supplies at Friant Dam, and then used to estimate the amount of water available for release to the San Joaquin River or diversion to the Friant-Kern and Madera canals. Details regarding CALSIM can be found in the Investigation Phase 1 Hydrologic Modeling TM.

The amount of energy generated is a function of the net head available (gross head less hydraulic losses), water flows available from Fine Gold Reservoir, efficiency of the pump-turbine equipment as a generator, and the period of time under consideration (often, monthly, or annually). Similarly, energy required for pumping is a function of the pumping head (gross head plus hydraulic losses plus requirements for submergence), flow of water to be pumped, efficiency of the pump, and the period of time under consideration.

Monthly CALSIM data included flows to be pumped into Fine Gold Reservoir from Millerton Lake and releases to be made from Fine Gold Reservoir to Millerton Lake. Water volumes and evaporation at Fine Gold Creek Reservoir and at Millerton Lake were also supplied, along with inflow to Fine Gold Reservoir from Fine Gold Creek, and canal and river releases from Friant Dam. Tables of reservoir areas and volumes with respect to reservoir elevations were provided for Fine Gold Reservoir and Millerton Lake. From this information, water levels in Fine Gold Reservoir and Millerton Lake were calculated, and heads required for pumping and those available for power generation were determined. Output from the CALSIM program took into account flood storage and dead storage requirements.

Operating scenarios emphasized water management objectives, not hydropower production objectives. Specifically, estimates were made for CALSIM single-purpose analysis operating scenarios that would release water for San Joaquin River water quality and restoration purposes. These scenarios were chosen because together they provide a range of water demands on the reservoir. The water quality single-purpose analysis scenario holds new water yield in storage until it is released in the late irrigation season to improve the quality of water in the San Joaquin River. In contrast, the restoration flow single-purpose analysis scenario makes peak releases of water in the spring to increase San Joaquin River flows. No modifications were made to the CALSIM single-purpose analysis scenarios to enhance potential energy generation or potential net energy sales revenue.

For both operating scenarios, a Fine Gold Reservoir with water storage capacity of 800 TAF, which approximates the size of the larger dam options considered and which allows for reasonable comparisons to be made to potential reservoirs of similar size in the Temperance Flat area. (Results for those surface storage options are reported in the Temperance Flat Reservoir TM.)

In the spreadsheet analysis, assumptions were made regarding pump-turbine and motor-generator efficiencies, head losses in water passages, submergence, and minimum and maximum heads and flows for pumping and generating. From the above-mentioned data and assumptions, preliminary estimates were made of the energy required for pumping and energy generated on an annual basis.

FACILITIES

The project would consist of a pump-generating station located downstream of Fine Gold Dam at Millerton Lake in a location to meet the pump-turbine requirements for submergence. The pump-turbine station would not, therefore, be located at Fine Gold Dam but instead a short distance downstream.

ASSUMPTIONS

An overall constant pump-motor efficiency of 0.85 and an overall turbine–generator efficiency of 0.80 were assumed for the pump-turbine equipment for this prefeasibility-level analysis to take into account the efficiencies of the pump-turbine, motor-generator, and step-up transformers, and also the effects of unscheduled downtime.

The installed capacity of generating units is assumed to be approximately 100 megawatts (MW) to 125 MW. It is assumed this capacity would be provided by three or four units so that the pumping-generating station could operate at low as well as high discharges.

Releases at heads below 100 feet were assumed not to generate energy. No restrictions were placed on higher heads. To account for head losses in waterway passages during generation, a deduction of 5 percent was made on gross head. To obtain the pumping head, an amount equivalent to 20 percent was added to the gross head.

ESTIMATED GENERATION

A summary of the range of potential pumping energy required and energy potentially generated for a Fine Gold Reservoir of 800 TAF capacity is shown in Table 4-1. Results indicate the pumping energy required and offsetting energy that might be generated. Further study is needed to determine the cost of the pump-back facilities and to ascertain the preferred facility layout. Further study also may be warranted of water storage requirements and pump-turbine and motor-generator equipment in view of the wide variation in head and flows available for generation in the operating scenarios.

An example of flow and head variations is seen in the 800 TAF reservoir with water quality single-purpose analysis. Maximum and average generation heads are 513 feet and 394 feet, respectively; maximum and average generation flows are 3,938 cfs and 401 cfs, respectively.

TABLE 4-1. ESTIMATED PUMPING REQUIREMENT AND GENERATING POTENTIAL FOR FINE GOLD RESERVOIR

Storage (TAF)	Operating Scenario	Avg. Annual Energy Generation (GWh)	Avg. Annual Pumping Energy (GWh)
800	WQ	80 - 100	140 - 170
	RF	70 - 90	130 - 160

Key:
GWh – gigawatt-hours
RF – restoration flow single-purpose analysis scenario
TAF – thousand acre-feet
WQ – water quality single purpose analysis scenario

POTENTIAL FOR PUMPED STORAGE

Fine Gold Reservoir is presently planned as a water storage reservoir that would operate as a pump-back hydroelectric energy project. Water would be pumped into the reservoir and released when water requirements dictate. The timing of energy use and generation would therefore be governed by water management operating objectives. Conversely, a pumped storage project would be governed by hydroelectric energy production objectives. A pumped storage operation typically pumps water into an upper reservoir during non-peak energy price periods and generates when the energy can be sold at peak period prices or when power system requirements make it advantageous for generation capacity to go on-line.

From a hydropower perspective, the proximity of Fine Gold Reservoir to Millerton Lake makes a pumped storage arrangement a potential consideration. Physically, Fine Gold Reservoir could be designed for pumped storage. Determining whether a pumped storage project would be economically feasible or would conflict with reservoir operating requirements, however, requires further study.

TRANSMISSION

There are two major power lines, one about 6 miles south-east of the site and the other about 15 miles south-west of the site. It is anticipated that pumping power would be received from and generation delivered to one or both of these power lines. Suitable interconnection infrastructure would need to be constructed.

CHAPTER 5. ENVIRONMENTAL CONSIDERATIONS

This chapter qualitatively describes potential effects of reservoir development, indicating the extent to which expected or potential environmental effects might pose a constraint to the storage options considered. Where evident, opportunities for improving environmental resources or mitigating adverse effects have been noted. The analysis focused on botany, terrestrial wildlife, aquatic biology, water quality, recreational resources, cultural resources, land uses, and mineral resources. Temporary construction-related disruptions and impacts are discussed in Chapter 3.

Identification of constraints was conducted at a preliminary, prefeasibility-level of planning, consistent with the current phase of the Investigation. Criteria considered were based, in part, on criteria commonly used to evaluate environmental impacts of projects under the National Environmental Policy Act (NEPA) and the California Environmental Quality Act (CEQA). Application of criteria that may be used for NEPA or CEQA evaluation does not imply that the analysis was conducted at a level necessary to support an Environmental Impact Statement or Environmental Impact Report. Considerations included presence of special status species (e.g., species as listed as endangered or threatened), species of concern, or sensitive habitats; relative amounts of affected riparian or wetland habitat; effects on native or game fish; conflict with established recreational uses or land uses; presence of nationally registered historic places, sacred Native American sites, or Traditional Cultural Places (TCPs); permanent disruption or division of established communities; loss of energy production facilities.

BOTANY

Foothill woodland and riparian habitats are found in the area. Eight special status plant species have the potential to occur around Fine Gold Creek, including six species Federally or State-listed as endangered or threatened. Three of these six species are vernal pool species with low to moderate probability of occurring within the potential reservoir area. Two other two special status species are CNPS List 1B species.

Constraints

The greatest botany-related constraints to development of a reservoir at the site would likely be associated with tree anemone and Hartweg's pseudobahia, which are listed as endangered or threatened, and wetland and riparian habitats. Aerial photographs do not show significant riparian habitat; however, the numerous tributaries to Fine Gold Creek could have narrow riparian corridors. Seeps, springs, and other wetlands could be present as well. A few areas within the elevation 900 pool have some potential for vernal pool species. More such locations occur within the elevation 1,100 pool. Wetland and riparian losses are likely to be proportional to the increase in pool area. Tree anemone is identifiable for much of the year and could be surveyed outside of its normal blooming season.

Opportunities

If mitigation requirements for wetland and riparian habitat are not extensive, there may be suitable mitigation opportunities in the immediate vicinity.

WILDLIFE

Fine Gold Creek is surrounded by foothill pine–oak woodland habitat with pockets of grassland, and wetland and riparian habitats associated with hillside seeps and vernal pools. Varying degrees of riparian habitat occur along the stream. A diverse wildlife community is expected. Several sensitive species of wildlife are known to have been present in the general area, including California tiger salamander, western spadefoot toad, and fairy shrimp from vernal pools. Western pond turtles occur in Fine Gold Creek, and foothill yellow-legged frogs and tri-colored blackbirds are also likely to occur.

Constraints

The greatest wildlife-related constraints would be associated with the loss of habitat known to host western pond turtles, and potentially other sensitive species. Additional constraints would be associated with vernal pools, if they would be affected by construction of Fine Gold Dam and Reservoir.

AQUATIC BIOLOGY/WATER QUALITY

Aquatic biological resources of Fine Gold Creek and its potentially inundated tributaries have not been determined, but would probably be similar to those present for the Friant Dam and Temperance Flat Dam storage options, described in separate TMs.

Because of the relatively low elevation, fish are probably warm-water species, such as the San Joaquin Valley subspecies (or “form”) of California roach, which is on the “Watch List” of the State of California Fish Species of Special Concern.

Constraints

The likely effects of maximum dam height and reservoir elevation are evaluated directly and effects of lesser increases are approximated by interpolation.

A new 580-foot-dam would raise the maximum pool elevation in the Fine Gold Creek arm of Millerton Lake to about elevation 1,100, inundating a large portion of the creek and its tributaries. The principal local effects on aquatic biological resources result from replacing riverine type habitat in the existing reservoir arm and stream habitat upstream with open, deep lacustrine habitat. Populations of fish and other organisms adapted to a more riverine environment would be reduced or eliminated from inundated areas, while those of species adapted to lacustrine conditions would be enhanced. The most likely native fish species to be adversely affected would be the California roach, which is potentially present in the creek and is generally not found in lakes. Further research would be needed to determine if this species occurs in the area of the site.

The most important constraints of this option may be associated with changing the location of Millerton Lake inflow from the San Joaquin River to Fine Gold Creek. Although in the first instance, water would enter Millerton Lake from the San Joaquin River, the use of Fine Gold Reservoir for pumped storage would mean that a substantial portion of the water in Millerton Lake would be stored in Fine Gold Reservoir for some intermediate period of time, except during sizeable flood events on the main stem of the San Joaquin River.

Fine Gold Reservoir would be deep and relatively sheltered from wind, so it would likely stratify during summer. Water flowing into Millerton Lake from Fine Gold Creek would be comparatively cold. The net result would be a substantial redistribution of water temperatures in Millerton Lake, potentially increasing the volume of the reservoir's cold-water pool. Effects of a smaller dam on Fine Gold Creek would be similar in kind, but of lesser magnitude than those of the larger dam.

Seasonal water level fluctuations of the new Fine Gold Reservoir would likely be substantial, with a number of potential adverse effects on fish. Changes in the extent of water level fluctuation that occurs in Millerton Lake would depend on how the reservoirs are jointly operated. Rapidly changing water levels would result in habitat instability, particularly for shallow water species. Such fluctuations adversely affect nearshore spawners such as largemouth bass that spawn in Millerton Lake in the spring, when reservoir water levels rise. The rising water level would result in increased water depth of largemouth bass nests and could expose them to water temperatures too cold for the developing eggs. Spotted bass, introduced into Millerton Lake because they spawn in deeper, colder water than largemouth bass, and are better able to withstand rising water levels, would probably be less affected by the maximum pool increase than largemouth bass.

Water level fluctuations also inhibit development of shoreline vegetation. Shoreline vegetation provides cover and feeding substrates for many warm-water game species in the reservoir. Vegetation also stabilizes shoreline sediments, reducing erosion and sedimentation. Due to effects on vegetation, increases in water level fluctuations would adversely affect most fish species in the reservoir.

Opportunities

Developing a reservoir on Fine Gold Creek would result in a substantial increase in total volume of fish habitat. Deep, cold-water habitat used by species such as trout and salmon would be most enhanced, but because the increase in reservoir surface area could be great, lacustrine habitat of all types could be greatly increased. Stocking the new reservoir with salmon and other cold-water species should be considered.

If existing nearshore vegetation in the Fine Gold Creek drainage area were not removed prior to building the new dam, this vegetation would be inundated, providing a short-term increase in nutrient levels in the reservoir and enhancing habitat structure in nearshore areas. Both effects would benefit fish production.

RECREATION

Fine Gold Creek traverses private property. No developed recreation facilities are within the immediate area. It is likely, however, that some recreation occurs in the area, particularly where unpaved roads provide access to undeveloped areas along Fine Gold Creek.

Constraints

Because no developed recreation facilities are present along Fine Gold Creek or its tributaries, neither option under consideration would result in impacts to existing facilities. With the exception of recreational mining and stream fishing, most dispersed uses that may currently occur along Fine Gold Creek would continue to be available along the reservoir shoreline. Further research is needed to determine whether recreational miners would be displaced if either option were implemented.

It is not expected that recreational opportunities associated with the San Joaquin River will be affected. Pumped storage operations are not expected to affect recreation users at Millerton Lake, but this would depend on how integrated operation of the reservoirs would affect Millerton Lake levels.

Opportunities

Creating Fine Gold Reservoir would provide new reservoir recreation opportunities such as fishing and boating. Depending on reservoir size, new fishing and boating opportunities could draw more visitors, thereby creating demand for new facilities. A smaller reservoir would not warrant developing major recreational facilities. Conversely, day and potentially overnight facilities should be considered if a larger reservoir option is implemented.

Pumping operations could result in substantial water level fluctuations in Fine Gold Reservoir, thereby creating undesirable recreation conditions and potential safety hazards. Further information is needed to determine whether recreation at a new Fine Gold Reservoir could be accommodated under pumping conditions.

CULTURAL RESOURCES

Fine Gold Creek is within traditional territory of the Northfork Mono people (Spier, 1978a) or the Dumna/Toltichi Yokuts (Kroeber, 1925), Chuckchansi Foothill Yokuts (Spier, 1978b), and Northfork Mono (Gifford, 1932; Spier 1978a). Chuckchansi people presently live on and around the Picayune Rancheria in Coarsegold.

A recent archaeological records search by Reclamation archaeologists indicates the presence of three known archaeological sites within the potential reservoir pool (Welch, 2002). Two of the sites are prehistoric, with BRMs and lithics; the third is a standing two-story house. The records search identified no archaeological surveys or excavations within the reservoir area.

Constraints

Some cultural resources are known to be present, and additional resources are likely to be present as well. With currently available data, it is unclear whether the three known archaeological sites would be impacted by the potential reservoir in its various configurations. Inundation of archaeological sites (prehistoric or historic) can result in loss of important scientific data. No properties eligible for the National Register of Historic Places are known to be present. No Native American sacred sites or TCPs are known to occur, but Chuckchansi Yokuts concerns are expected.

Opportunities

Inundation damage to archaeological sites can be mitigated with scientific data recovery programs. Reservoir projects also provide an opportunity for public interpretation of the past. Impact to archaeological sites from ancillary facilities, such as roads, power lines, or other structures, may be avoided through design or facility placement.

LAND USE

The area appears to be largely undeveloped and in relatively pristine natural condition. Some rural residential uses, such as scattered single-family homes and related farm structures and access roads, are present.

Constraints

Developing Fine Gold Reservoir would not result in inundation of an existing community; only a small number of scattered properties, structures. and roads would be displaced. The primary facility that would be inundated would be Road 210, which lies below elevation 1,100.

However, dam construction and inundation of the reservoir area would transform a large, pristine, heavily wooded area with potential for many biological and cultural resources. Its close proximity to recreation facilities at Millerton Lake makes it also likely that with improved access, effects could occur from visitation. Future review of General Plan and zoning designations might reveal constraints.

MINERAL RESOURCES

Historically, three major mining districts were present near Millerton Lake (Rivers, 1995). In May 2002, evidence of a mining sluice and past placer mining was noted along Fine Gold Creek within the potential reservoir area. Constructing a dam at the Fine Gold site would inundate these mining sites. In the context of historic value, remnants from past mining activities would be dealt with as cultural resources. In the context of soil and water quality, mining residuals would be dealt with as potential sources of contamination.

Constraints

Literature research of historic mining operations in the vicinity of what is now Millerton Lake, combined with observations during field visits in the Temperance Flat area, located along the upper reaches of Millerton Lake, suggest that mining residuals that would adversely impact water quality are unlikely to be present. Further investigation would be needed to confirm this for the potential Fine Gold Reservoir area.

Opportunities

The potential for adverse effects from inundation of abandoned mines or mine tailings in the Fine Gold Creek drainage area could be minimized by removing mine wastes and sealing the mines prior to dam construction and reservoir filling.

CHAPTER 6. FINDINGS AND CONCLUSIONS

This TM described a potential dam and reservoir on Fine Gold Creek. The new reservoir would function as a pump-back storage facility, with water pumped up from Millerton Lake for later release, allowing partial recovery of hydroelectric energy. Pumping water from Millerton Lake to Fine Gold Reservoir would provide an opportunity to increase available storage space in Millerton Lake, which could then capture a larger portion of San Joaquin River flood flows. Natural runoff from Fine Gold Creek would supplement water pumped from Millerton Lake.

Two potential dam types could be constructed: an RCC structure or a CFRF dam. Two dam heights were considered, 380 feet and 580 feet, which correspond to total storage capacities of approximately 130 TAF and 780 TAF, respectively. The higher dam option would require construction of a saddle dam on the right (west) rim of the reservoir. During construction, a temporary cofferdam approximately 80 feet high would be required above the permanent dam site to divert Fine Gold Creek flows; a second cofferdam approximately 60 feet high would be required to keep water from Millerton Lake out of the construction zone. One or more diversion tunnels would be required. The number and placement of tunnels would depend on the dam type selected.

Geologic conditions appear suitable for dam construction. Raw materials could be obtained from within the potential reservoir inundation area.

Field costs for constructing each option were estimated at 2003 price levels and range from \$160 million for the 130 TAF reservoir up to \$430 million for the 780 TAF reservoir. These estimates represent direct costs to construct the dam and appurtenant features only.

It is estimated that, on average, 130 GWh – 170 GWh would be required annually to pump water into an 800 TAF Fine Gold Reservoir, generating 70 GWh – 100 GWh upon release.

Creation of Fine Gold Reservoir would be expected to cause adverse environmental impacts. Extensive pine and oak woodland habitat would be affected, as would pockets of riparian and wetland habitats. Vernal pools and special status species of plants, terrestrial wildlife, and fish may be present in the inundation area and in Fine Gold Creek. Pumping and releasing operations could affect water temperatures in Millerton Lake and cause fluctuations in water levels in both Millerton Lake and Fine Gold Reservoir. Lake level fluctuations would affect several species of fish.

No technical issues were identified that would physically prevent a dam from being constructed on Fine Gold Creek. However, further research would be required to more fully define the extent of resulting environmental impacts and how adverse environmental impacts could be mitigated. Fine Gold Reservoir was retained for further consideration in the Investigation as a surface water storage option.

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Geologic support and follow-up field reconnaissance was performed by the Mid-Pacific Region and Technical Service Center geology staff. The Mid-Pacific Region coordinated surface geologic mapping of the site and the initial borrow area investigations.

The Technical Service Center provided the seismotectonic evaluation for all the Upper San Joaquin River Basin Storage Investigation sites. Other Technical Service Center groups providing support for this report include the following:

- Geotechnical Engineering Group
- Engineering Geology Group
- Estimating Group
- Waterways and Concrete Dams
- Hydraulic Equipment Group
- Seismotectonics and Geophysics Group
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